CHAPTER 10
SEEPAGE CONTROL THROUGH EARTH ABUTMENTS ADJACENT TO STRUCTURES AND BENEATH SPILLWAYS AND STILLING BASINS

10-1. Through Earth Abutments. Earth and rock-fill dams, particularly in glaciated regions, may have pervious material, resulting from filling of the preglacial valley with alluvial or morainal deposits followed by the down-cutting of the stream, in one or both abutments (Twelker 1957). Seepage through the pervious abutment(s) is combined with through seepage and under-seepage to determine the total seepage loss. As mentioned previously, the purpose of the project, i.e., long-term storage, flood control, hydropower, etc., will determine the allowable seepage loss. Seepage control through earth abutments is provided by extending the upstream impervious blanket in the lateral direction to wrap around the abutment up to the maximum water surface elevation, by placing a filter layer between the pervious abutment and the dam downstream of the impervious core section, and, if necessary, by installing relief wells at the downstream toe of the pervious abutment. At the North Branch of Kokosing Dam, Ohio, the left abutment is an outwash terrace consisting of sands and gravels with layers of silt and clay as shown in figure 10-1. Seepage control through the pervious abutment was provided by a 5-ft-thick impervious upstream blanket which wrapped around the left abutment, a filter layer between the pervious abutment and the dam downstream of the impervious core (see figure 10-2), and three fully penetrating relief wells at the downstream toe of the pervious abutment (U. S. Army Engineer District, Huntington 1969).

10-2. Adjacent to Outlet Conduits. When the dam foundation consists of compressible soils, the outlet works tower and conduit should be founded upon or in stronger abutment soils or rock. When conduits are laid in excavated trenches in soil foundations, concrete seepage cutoff collars shall not be provided solely for the purpose of increasing seepage resistance since their presence often results in poorly compacted backfill around the conduit. Collars, with a minimum projection from the conduit surface, will be used over conduit joints to protect against joint displacements resulting from differential movement on yielding foundations. Excavations for outlet conduits in soil foundations shall be wide enough to allow for backfill compaction parallel to the conduit using heavy rolling compaction equipment. Equipment used to compact along the conduit should be free of framing that prevents its load transferring wheels or drum from working against the structure. Excavated slopes in soil for conduits should be no steeper than 1V to 2H to facilitate adequate compaction and bonding of backfill with the sides of the excavation. Drainage layers should be provided around the conduit in the downstream zone of embankments without pervious shells. A concrete plug shall be used as backfill in rock cuts for cut-and-cover conduits within the core zone to ensure a watertight bond between the conduit and vertical rock surfaces. The plug, which can be constructed of lean concrete, should be at least 50 ft long and extend up to the original rock surface. In embankments having a random or an impervious downstream shell, horizontal drainage layers should be placed along the sides and over the top of conduits downstream of the impervious core. Where outlet structures are to be located in active seismic areas, special attention must be given to the possibility of movement along-existing or possibly new faults (EM 1110-2-2300).

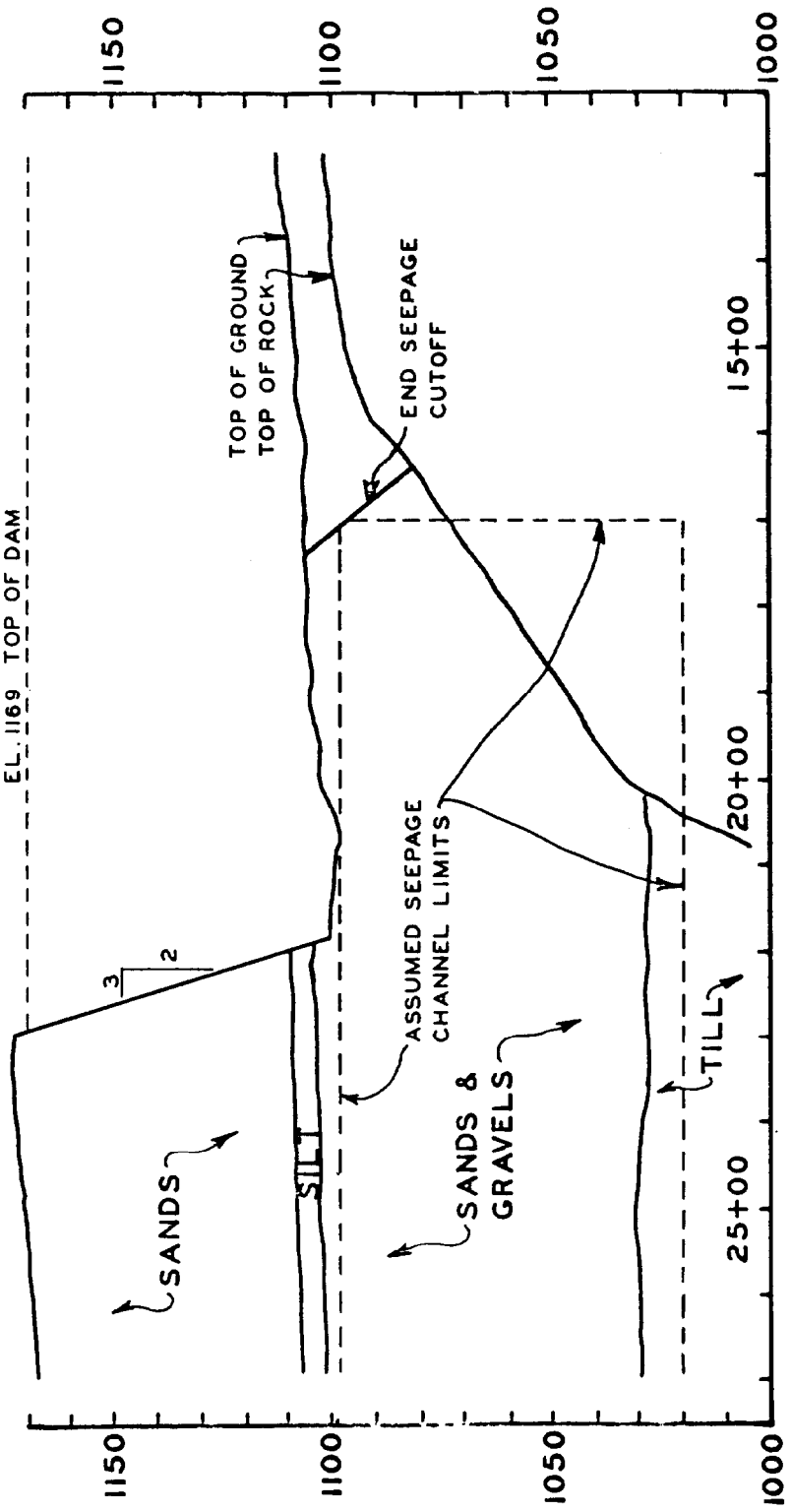

Figure 10-1. Profile of left pervious abutment at North Branch of Kokosing Dam, Ohio (from U. S. Army Engineer District, Huntington[87])

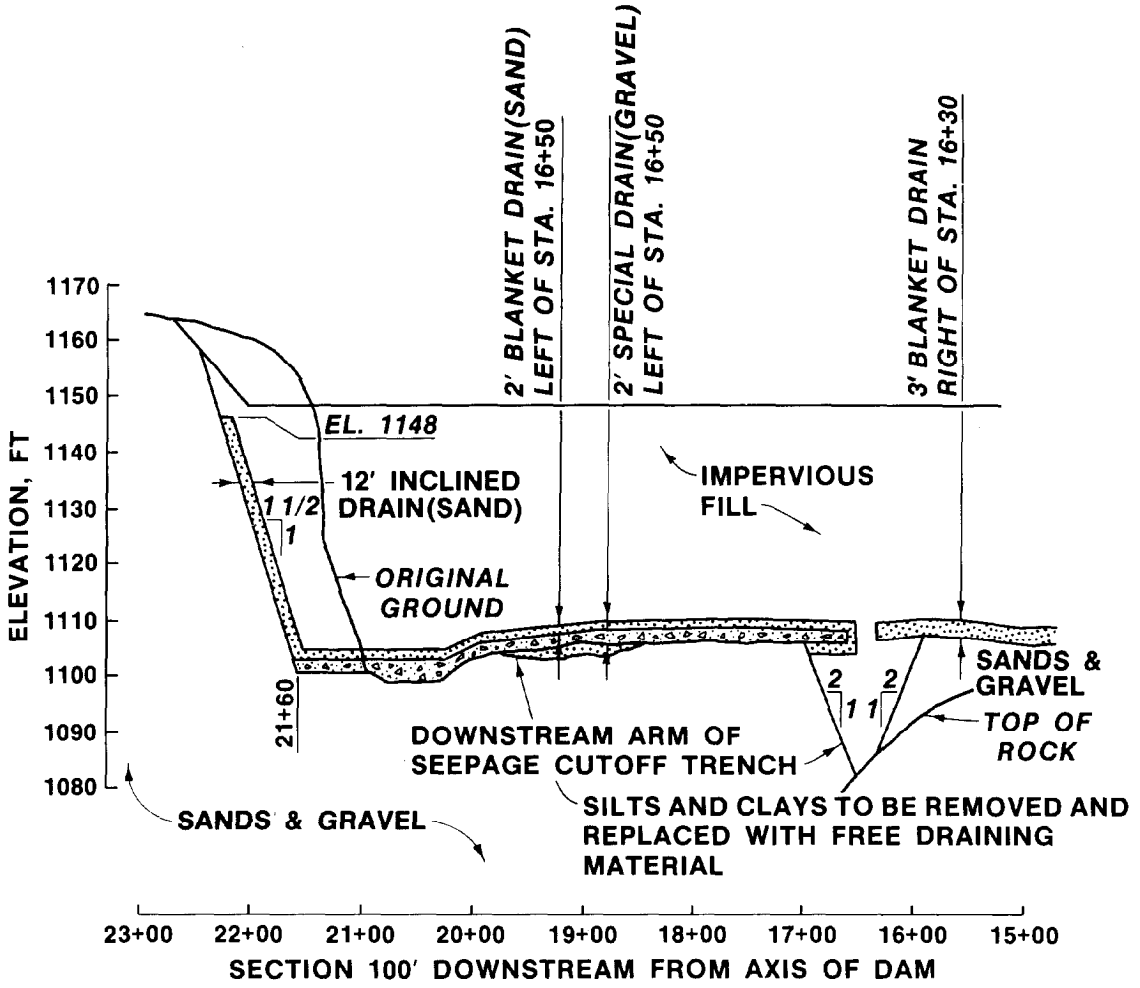

Figure 10-2. Seepage control of left pervious abutment at North Branch of Kokosing Dam, Ohio (from U.S. Army Engineer District, Huntington[87])

10-3. Beneath Spillways and Stilling Basins. Adequate drainage should be provided under floor slabs for spillways and stilling basins to reduce uplift pressures. For soil foundations, a drainage blanket under the slab with transverse perforated pipe drains discharging through the walls or floor is generally provided, supplemented in the case of stratified foundations by deep well systems. Usually drainage of a slab on rock is accomplished by drain holes drilled in the rock with formed holes or pipes through the slab. The drainage blanket is designed to convey the seepage quickly and effectively to the transverse collector drains. It is designed as a graded reverse filter with coarse stones adjacent to the perforated drain pipe and finer material adjacent to the concrete structure to prevent the migration of fines into the drains. Outlets for transverse drains in the spillway chute discharge through the walls or floor at as low an elevation as practical to obtain maximum pressure reduction. Wall outlets should be 1 ft minimum above the floor to prevent blocking by debris. Cutoffs are provided at each transverse collector

pipe to minimize buildup of head in case of malfunction of the pipe drain. Drains should be at least 6 in. in diameter and have at least two outlets to minimize the chance of plugging. Outlets should be provided with flat-type check valves to prevent surging and the entrance of foreign matter in the drainage system. For the stilling basin floor slab, it may be advantageous to place a connecting header along each wall and discharge all slab drainage into the stilling basin just upstream from the hydraulic jump at the lowest practical elevation, in order to secure the maximum reduction of uplift for the downstream portion of the slab. A closer spacing of drains is usually required than in the spillway chute because of greater head and considerable difference in water depth in a short distance through the hydraulic jump. Piezometers should be installed in the drainage blanket and deeper strata, if necessary, to monitor the performance of the drainage systems. If the drains or wells become plugged or otherwise noneffective, uplift pressures will increase which could adversely affect the stability of the structure (EM 1110-2-2400 and EM 1110-2-2300).